PARORCHIS ACANTHUS VAR. AUSTRALIS, N. VAR., WITH AN ACCOUNT OF THE LIFE CYCLE IN SOUTH AUSTRALIA

By L. Madeline Angel *

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SUMMARY

1. A review of the history of *Parorchis acanthus* Nicoll and its synonymy is given.
2. Stages in the life cycle of *P. acanthus* var. *australis* n. var. are described.
3. The variety differs from the type species mainly in the absence of an excretory tube in the tail of the cercaria. Other relatively minor differences are noted.
4. The cercaria has been found as a natural infection in South Australia in *Bembicium auratum* (Quoy and Gaimard), *B. melanostoma* (Gmelin), *B. nanum* (Lamarck), and *Emozamia flindersi* (Adams and Angas). It encysts on the surface of hard objects, including a number of invertebrate animals, which are probably only accidental hosts.
5. Cysts were fed to seagulls, *Larus novae-hollandiae* Stephens, and adult trematodes were recovered. The adult was found as a natural infection in 1 of 25 seagulls examined by the late Professor Harvey Johnston.
6. The incidence of infection in the different snail hosts is given. This was highest in *Bembicium auratum* (up to 66%). The percentage of infection as determined from those snails which gave off cercariae when isolated, is much less than the true percentage, determined by crushing the snails.

The type as well as other representatives of the adult and larval stages have been deposited in the South Australian Museum.

This work was commenced with the late Professor Harvey Johnston, to whom I am greatly indebted for his unfailing help. I wish to acknowledge with gratitude the help given by Mrs. H. Anderson, who supplied the figures of the infection of snails from the Patawalonga Creek determined by crushing, as well as other details. Acknowledgment is also made of help given by the staff of the South Australian Museum in identifying intermediate hosts, and by members of this department in collecting material, as well as in other ways.

INTRODUCTION

In 1907 and 1912 Lebour described *Cercaria purpura* sp. inq. from *Purpura lapillus* in Great Britain. Later (1914) she identified it, on the grounds of morphological similarity, as *Parorchis acanthus* Nicoll 1907. *P. acanthus* was originally described as *Zeugorchis acanthus* (Nicoll 1906) and later renamed and redescribed (Nicoll 1907 a, 1907 b), *Zeugorchis* being pre-occupied.

Stunkard and Shaw (1931) described *Cercaria sensifera* from *Urosalpinx cinereus* from Wood's Hole, Massachusetts, stating that it might be identical with *Cercaria purpurae*. They also suggested that *C. sensifera* might be the larval stage of *Parorchis avitus* Linton 1914. (Linton's type material, from the herring gull, *Larus argentatus*, was from the same region.) Linton (1928) had discussed the possibility of synonymy of *Parorchis avitus* with *P. acanthus*, but did not change his classification. In 1932 Stunkard and Cable recorded *Thais* (*Purpura*) *lapillus* as another host of *Cercaria sensifera*. They had fed cysts of this form to guinea pigs, white rats, mice and two species of tern, and obtained immature flukes, which they identified as *Parorchis avitus*, only from the terns, *Sterna hirundo* and *S. dougalli*. The diagnosis was confirmed by Linton.

Cable and Martin (1935), who obtained mature adults after feeding meta-

* Department of Zoology, University of Adelaide, South Australia.

cercariae of *Cercaria sensifera* to herring gulls, concluded that *Parorchis avitus* was invalid, and was a synonym of *P. acanthus*. *Cercaria sensifera* was thus synonymous with *C. purpurae*.

Rees (1937) from other evidence, independently suggested that *C. sensifera* and *C. purpurae* were identical and that the names of the adults were synonymous. This suggestion was supported by a later examination of the adult parasites (Rees 1939). Dawes (1946) listed *Parorchis avitus* as a synonym of *P. acanthus*.

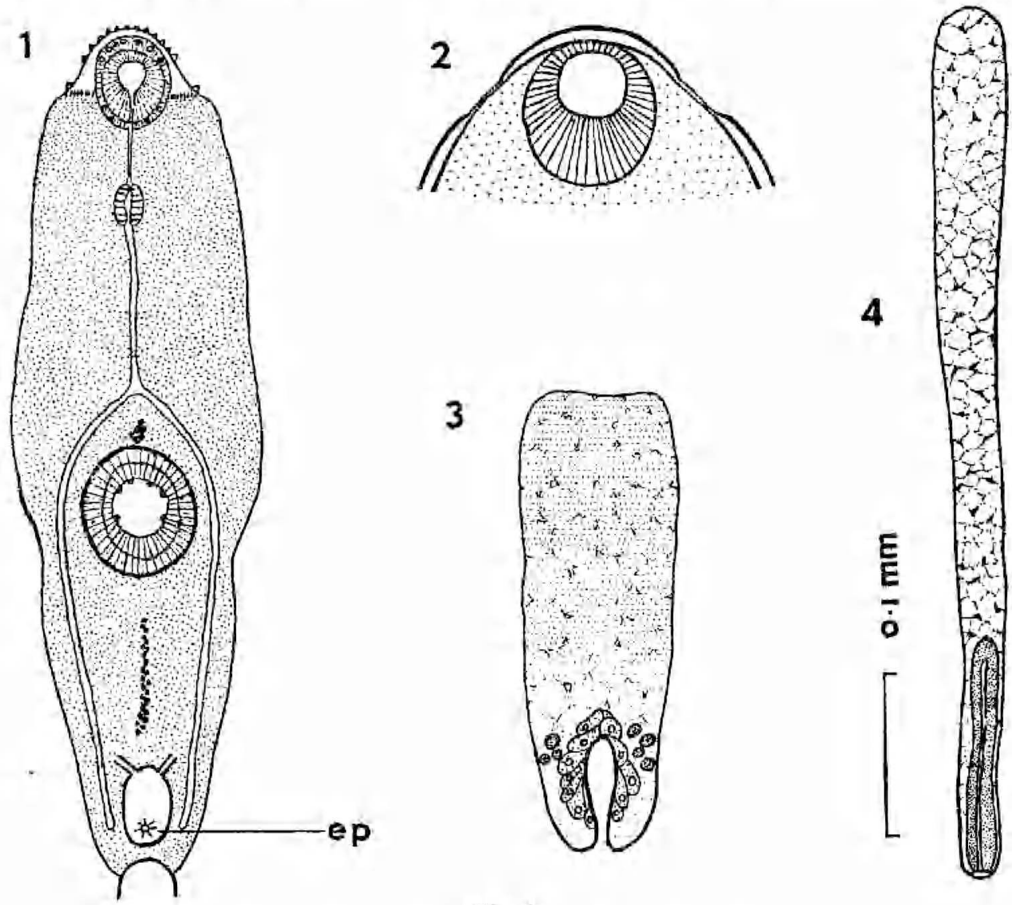

Fig. 1

Parorchis acanthus var. *australis*. The cercaria.

Fig. 1, stained and mounted; excretory bladder and pore from living specimen. Position of dorsal collar spines indicated. 2, anterior end of body to show narrowing of cuticle. 3, 4, tail; 3, living, contracted; 4, fixed, elongated.

Fig. 1, 4 to same scale; 2, sketch; 3, sketch. ep, excretory pore.

Maxon and Pequegnat (1949) described a cercaria (Echinostome II) from Upper Newport Bay, California, which was probably identical with that described by Hunter (1943) as the cercaria of *P. avitus* (*Cercaria sensifera* Stunkard and Shaw 1931). Reish (1950) recorded *Parorchis acanthus* from *Larus occidentalis* from Newport, Oregon. Rediae and cercariae which agreed with the descriptions given by Stunkard and Cable (1932) for those of *Parorchis avitus* (= *P. acanthus*) were found in *Thais emarginata* from this vicinity. Encysted cercariae were fed to one golden hamster and one mallard duck, but did not develop in either animal.

The present investigation was initiated when megalurous cercariae were found in a marine tank containing *Bembicium auratum* (Quoy and Gaimard) (Anderson, personal communication). These cercariae, which were similar to *Cercaria purpurae* Lebour as described by Rees (1937), were later found to be a common parasite of the snails. The cercariae encysted on any hard surface. Cysts, collected from glass dishes in which the host snails were isolated, were fed to seagulls, from which adults of a species of *Parorchis* were recovered later. In all stages of the life cycle the only significant difference between the Australian form and *P. acanthus* Nicoll was in the absence of an excretory tube in the cercarial tail, but it is thought that this difference is sufficient to warrant placing the Australian specimens in a distinct sub-species, for which the name *Parorchis acanthus* var. *australis* is proposed. A description of the life history of this form follows.

THE EGG AND MIRACIDIUM

Eggs were dissected from the adult, fixed in formalin and cleared in glycerine; the range of the larger ones was from 94 by 56μ to 98 by 64μ. (Rees (1940) found that ripe eggs were considerably larger than those in which the miracidium was freely formed; her measurements were made in sea-water, the ripe eggs being 130 by 68 μ, and the young ones 90 by 35 μ). The eggs did not appear to hatch freely, but those examined had been obtained from a specimen kept in the refrigerator for two or three days in normal saline, and under these somewhat unnatural conditions the eggs may have been extruded before they were fully mature. One miracidium hatched quickly when it was placed in sea-water under a coverslip, and this was the only one which remained alive under a coverslip for any length of time; it died immediately when neutral red was added. In this one specimen all the main features described by Rees (1940) could be seen, *i.e.*, the rostrum, penetration glands and gland pores, the united kidney-shaped eyes, the brain region, the apical gland, the lateral processes (which help the miracidium in its escape from the shell), and the contained redia lying at the posterior end of the resting miracidium. The arrangement of the epithelial cells was not examined, but the subepithelial layer of cells was apparent, and the arrangement of the cilia also corresponded to Rees' description. No flame cells were seen, but parts of the excretory tubes were visible in the same positions as figured by Rees.

THE REDIAE

The rediae were white and opaque. The small (first generation) rediae varied from 0·34 by 0·052 mm. to 0·63 by 0·060 mm. in ten formalinised specimens, the average being 0·465 by 0·060 mm. They agreed with the description given by Stunkard and Shaw (1931) in having a muscular, lip-like snout in front of the "oral sucker"; also the posterior tip of the body was protruded in a tail-like or foot-like protuberance, used, like the foot processes, in locomotion. The birth-pore, as in Rees' material (1937, p. 66) was thick-lipped, conspicuous and protrusible. Rees (1937, 1940) recorded that first generation rediae did not produce cercariae, but gave rise to twenty or more daughter rediae. Stunkard and Shaw (1931) stated that small rediae may contain one or more fully formed cercariae. No cercariae were observed in the small rediae of the South Australian material.

The large (second generation) rediae varied from 1·39 by 0·255 mm. to 1·92 by 0·345 mm. in ten formalinised specimens; the average size was 1·67 by 0·295 mm. Stunkard and Shaw (1931) stated that rediae increased to a length of 2·1 mm. and a width of 0·4 mm. (presumably in living material). Rees (1937), for living material, gave the measurement of a fully grown redia as 3·5 mm. by

0·46 mm. and of a young redia as 0·58 by 0·08 mm. It will be noticed that the size is greater than that of the Australian form. (Fixation of the rediae in formalin probably does not produce a very great change in size.)

THE CERCARIA

The cercaria was very similar (anatomically, in habit, and in reaction to intra-vitam stains) to that described by Stunkard and Shaw (1931) and Rees (1937), with the exception that an excretory system could not be demonstrated in the tail. Lebour (1912) recorded that the excretory system was not continued into the tail of *Cercaria purpurae*, but Stunkard and Shaw (1931) found this feature in *Cercaria sensifera*, and this supposed difference was one of the characters by which Stunkard and Cable (1932) separated *Parorchis acanthus* and *P. avitus*. However, in 1937 Rees noted the excretory tube in the tail of *Cercaria purpurae*. In 1953 (personal communication) Dr. Rees stated that the excretory tube in the tail was difficult to find in *Parorchis acanthus*; that other workers at Aberystwyth had experienced the same difficulty, but that its presence had been confirmed on several occasions.

No sign of an excretory tube in the tail was seen in several hundred cercariae examined over a period of eighteen months. Basic fuchsin did not make the details of the excretory system any clearer, as it does with most fresh-water cercariae; and horse serum, which is also very useful with most forms, caused the cercariae to encyst immediately, even in very dilute solution. However, the excretory system, with an excretory pore opening from the bladder to the ventral body surface, was clearly seen. This latter feature has not been mentioned by other authors. It would not be surprising, perhaps, if an excretory pore in the body should be present at the same time as the two pores in the tail, but failure to demonstrate the latter over such a long period cannot be ignored.

The number of collar spines was difficult to determine. It was at least 60, and in one specimen possibly 66; there were 10-11 on each side ventrally. Stunkard and Shaw (1931) recorded 44-48 spines on the dorsal surface and 10 on each side ventrally. Rees (1937) gave the total number as 64.

The ratio of oral sucker to acetabulum varied from 2 : 3 to 3 : 4 in living specimens.

Immediately anterior to the first row of body spines the cuticle was thinner for a short distance, after which it widened again in the region of the anterior papillae (fig. 1, 2). This thinning of the cuticle has not been described for *Parorchis acanthus*. It was noticeable in greatly compressed specimens, as well as in specimens stained with neutral red which were still elongating and contracting. The region of thinner cuticle was very much paler than the rest of the cuticle. The cuticular layer, which probably consists of cuticle plus cystogenous material, is 8-9 μ wide in living, flattened specimens; it stains a uniform, carmine colour with neutral red.

The primordia of the reproductive system are obvious in stained specimens.

The only feature in which the tail differed from the descriptions given by Stunkard and Shaw (1931, p. 265) and Rees (1937, p. 67), apart from the absence of an excretory tube, was that it was marked with very fine annuli on which were arranged minute spots, which might have been granules or tiny spines (fig. 3). These were variable in size, but even the largest were extremely small. The annuli were seen well after treatment with orange G; there were about six across the diameter of one of the large vacuolated cells of which the proximal part of the tail is composed. Stunkard and Shaw (1931) and Rees (1937) described the cuticle of the tail as being thin and smooth.

The following measurements were made on twenty specimens fixed by add-

ing an equal volume of boiling 10% formalin to the water containing the cercariae: body length 370-670 μ (average 450 μ); greatest width 130-225 μ (average 170 μ); width at "waist" (constriction of body immediately posterior to acetabulum) 105-180 μ (average 130 μ); tail length 265-595 μ (average 450 μ); tail width 45-60 μ (average 52 μ).

Rees (1937) found the body length to be 1·00 mm. expanded and 0·36 mm. contracted; breadth 0·09 mm. expanded, 0·35 mm. contracted. The number of specimens measured was not mentioned, nor was the method of fixation, but elsewhere in the paper it was stated that rediae and cercariae were examined in the living state. Presumably the measurements represent the upper and lower range for living cercariae examined under a coverslip, and are thus not to be compared with measurements of specimens fixed in formalin.

Stunkard and Shaw (1931) stated that fixed and stained specimens measured 0·21-0·47 mm. in length and 0·14-0·26 mm. in width; the tails varied from 0·12 to 0·26 mm. in length. The average body size of seven stained and mounted cercariae of *Parorchis acanthus* var. *australis* was 520 by 160 μ, and for the tail, 615 by 50 μ.

Too much importance should not be attached to differences in measurements of cercariae, especially when the state of preservation of the material is variable.

THE CYST

Stunkard and Cable (1932) concluded that the cercariae would encyst on almost anything with which they came in contact. *P. acanthus* var. *australis* encysts readily on glassware. Animals which were placed in contact with cercariae and on which cysts were formed were:—the cirripede *Elminius modestus* (mainly on the appendages); the isopods *Exosphaeroma gigas* and *Trichoniscus* sp. (mostly on the joints of the legs); insect larvae of the Acalyptrate group (the body surface of these became so thickly encrusted with cysts that the insects, though still alive, could barely move); the crab *Helice haswellianus* (the shell of the body and legs was heavily encrusted); and the lamellibranch *Amphidesma angusta* (on the shell, more concentrated on the free edges, and scattered on the free edge of the mantle). The lamellibranch *Anapella pinguis* did not become infected; this was buried in the sand, but the siphons were, of course, protruding. Rees (1948, p. 234) noted that cercariae of *P. acanthus* normally encyst round the aperture of the shell and on exposed parts of the body of the host, *Nucella* (*Purpura*) *lapillus*. Cysts of the Australian form were sometimes found on the operculum of *Bembicium auratum* (in one case thirty cysts were present on the outer surface and the same number near the edge of the inner surface of the operculum); and occasionally on the inner surface of the shell, but they were never observed round the aperture, and rarely on the outer surface of the shell.

Cyst formation follows the same course as that reported by Rees (1937). Stunkard and Cable (1932) found that most of the cercariae encysted within 48 hours of leaving the snail. The Australian cercariae encyst within a few hours. The cercariae encyst immediately when exposed to unfavourable conditions (such as too strong solutions of intra-vital stains), as was observed by Stunkard and Shaw (1931).

The average measurement of 20 cysts from which the rough outer coat had been removed was 200 by 180 μ. Rees gave the cyst diameter as 0·295 mm., of which the outer layer was 0·045 mm. thick; the cyst enclosed only by the inner coat would thus be 0·205 mm. in diameter. Lebour and Elmhirst (1922), however, described the cyst as "roundish oval," which is consistent with the shape of the Australian form.

THE METACERCARIA

Metacercariae were recovered by breaking the cyst wall with needles. This often resulted in damage to the metacercaria, but some were recovered intact. The following measurements apply to specimens mounted in canada balsam. The length of four specimens averaged 405 μ (range 300-470 μ). The average diameter of oral sucker was 65 μ, and of ventral sucker 82 μ (in three specimens). The metacercaria most favourably mounted for measuring was 400 by 255 μ, with the oral sucker 68 μ (long axis) by 75 μ, and the ventral sucker 87 μ in diameter. Lebour and Elmhirst (1922) gave the measurements (apparently in living specimens) of the oral sucker as 0·08 mm. and of the ventral sucker 0·10-0·14 mm.

The primordia of the genital system were slightly more obvious than in the cercaria; they consisted of two, small, darkly-staining masses of tissue. One, circular, or oval in the transverse plane, and situated immediately anterior to the acetabulum and posterior to the intestinal bifurcation, marked the position of the genital atrium and its associated structures. The other, slightly larger, circular or elongated in the longitudinal axis, and situated midway between the acetabulum and the posterior border of the body, was no doubt the primordium of the gonads and their ducts.

The excretory formula was the same as for the cercaria, that is $2\,[\,(3+3+3)+(3+3+3)\,]$.

THE ADULT

An accurate assessment of the number of collar spines was not possible in living specimens, and many of them disappeared in the preparation of permanent mounts. Nicoll (1907 b, p. 346) recorded the number as "about 60." He mentioned that immersion in a weak acid solution for even a short time caused the spines to disappear wholly or in great part, and suggested this as the reason for their absence in *Distomum pittacium* Braun, which he transferred to the genus Parorchis. Stunkard and Cable (1932, p. 333) gave the number of collar spines as "about 68." Other authors have not recorded the number of spines for the adult.

Table I gives measurements of adult and juvenile forms, with the measurements given by Nicoll (1907 b) and Linton (1914) for comparison.

Ovaries and testes were measured in three specimens mounted in balsam, in which all measurements were slightly less than when the flukes were measured in cedarwood oil.

The ovary was rounded or oval in outline; measurements were:—(1) 240 μ, (2) 290 μ in diameter, (3) 240 μ (long axis) by 255 μ. (Rees (1939) described the ovary as transversely oval, measuring 0·29 by 0·33 mm.) The margin of the testes was lobed; they were sometimes elongated in the longitudinal axis, and sometimes one was situated slightly in advance of the other. In a specimen 5·2 mm. long the right testis was 525 by 450 μ and the left 560 by 490 μ. In the other specimens the testes were larger, but had the appearance of being more compressed.

EXPERIMENTAL INFECTIONS

Four seagulls (*Larus novae-hollandiae*) and a white mouse were fed with cysts. The mouse did not become infected, but adult *Parorchis* were obtained from two of the seagulls.

Two seagulls caught at Tailem Bend[1] on the River Murray were kept in

[1] Although no work has been done in South Australia on the habits of the seagull, it seems likely that the birds return each day to the same feeding grounds. This view is supported by the fact that certain birds which can be identified by some deformity have been seen in the same place for several weeks at a time. Thus birds caught at Tailem Bend, although they probably return to a roosting ground near Lake Alexandrina (an inlet of the sea) each night, are, in all probability, frequenters of the river and its shores, and are considered unlikely to feed in places where *Bembicium* spp. occur.

TABLE I

	P. acanthus var. *australis*			*Parorchis acanthus*	
	I Adults	II Adults	III Juveniles	IV Nicholl (1907b)	V Linton (1914)
Length - - -	4·3–7·9 (6·0)	3·8 –6·2 (5·3)	2·3–4·5 (3·4)	3–5	3·96–5·88 (4·63)
Breadth at widest point -	2·7–3·4 (3·05)	2·0 –3·0 (2·5)	1·2–1·7 (1·46)	–3 mm.	2·10–2·66 (2·24)
Breadth at "waist" (mid-acetabular level) -	1·8–2·1 (1·93)	1·2 –2·0 (1·6)	1·0–1·4 (1·24)		1·21–1·68 (1·36)
Breadth across collar -	1·0–1·3 (1·12)	0·8 –1·3 (0·9)	0·6–0·7 (0·66)	0·82–0·87	
Pharynx—length - -		0·19–0·25 (0·22)		0·24	0·18–0·24 (0·20)
breadth - -		0·15–0·22 (0·19)		0·17	0·14–0·24 (0·19)
Oral Sucker - - -		0·4 –0·5 (0·47)		–0·5	0·36–0·49 (0·41)
Acetabulum - - -		0·9 –1·4 (1·04)		*	0·71–1·35 (0·92)
Ratio of oral sucker: acetabulum - - -		1 : 2·2		1 : 2 +	1 : 2·2

The figures give the range of measurements in millimetres. Mean values are given within brackets. Sucker ratios were determined from the measurements given.

I. 6 adults, obtained as result of feeding experiments, fixed in formalin without pressure, and measured before clearing.

II. 8 adults (those from I, plus two found as natural infections) measured in cedar wood oil.

III. 18 juveniles (obtained as result of feeding cysts to gulls) fixed in formalin and measured before clearing.

IV. Condition of specimens not stated, but possibly living; measurements other than length referred to an individual of about 4 mm. length.

V. Measurements of four mounted specimens.

* Acetabulum "rather more than twice as great" as oral sucker.

captivity for several weeks before the experiment was commenced. The first was given two insect (*Acalyptrate*) larvae which were heavily encrusted with cysts; it was killed 32 days later. No *Parorchis* were found, though four heterophyids and a blood fluke were recovered from the intestine. The second gull was fed with a large number of cysts scraped from the sides of the tank in which the snails were kept; they were given 46, 38, 31 and 17 days before the bird was killed, when five mature and nineteen immature specimens of *Parorchis* were recovered. Of these, four adults and twelve juveniles were in the cloaca, and the remainder in the rectum. When the bird was killed, a period of 10-11 weeks had elapsed since it could have acquired infection under natural conditions; it therefore seems almost certain that the juvenile, if not the adult, trematodes had developed from the cysts fed to the birds. Faeces from the birds obtained 1, 7, 22 and 29 days after commencement of the experiment were free of eggs.

Of four seagulls captured at St. Kilda beach (a few miles north of Adelaide), two were killed immediately; no *Parorchis* were recovered. The other two were given meat in which cysts had been packed; neither of the birds was interested in food, and it is doubtful how many of the cysts were ingested. The first gull died in two days; it was negative for *Parorchis*. The second died eight days after exposure to infection, and one medium-sized, egg-bearing specimen of *Parorchis* was found in the duodenum (length 4·7 mm.). If this specimen had developed as a result of the experimental feeding (its location in the duodenum and the fact that the three other birds from the same locality had not harboured the infection suggesting this) the trematode must have become egg-bearing in eight days, whereas nineteen specimens from the other experimental host (from Tailem Bend) were still immature at least seventeen days after they had been ingested as cysts. Stunkard and Cable (1932) found that specimens recovered fifteen days after infestation were not sexually mature.

Two attempts to infect *Bembicium* spp. with miracidia failed. In the first about 25 *Parorchis* eggs were put in a small tank with three *Bembicium nanum;* and in the second, seagull faeces collected from the Patawalonga mud-flats were used, with eight *B. auratum*.

The experiments were not repeated, because of the shortage of adult trematodes from which to obtain eggs.

INCIDENCE OF INFECTION IN SNAILS

The cercaria of *Parorchis acanthus* var. *australis* was first identified from *Bembicium auratum* (Quoy and Gaimard) collected from a tidal mud-flat at the mouth of the Patawalonga Creek, Glenelg, South Australia; a high percentage of the snails was found to be infected.[2] The number of infections detected by isolating each snail in a 3″ x 1″ tube over a twenty-four hour period was considerably less than the true number as determined by crushing the snails. For instance, from April to September 1951 (inclusive), of 582 *B. auratum* isolated, 64 (11%) gave off cercariae, while in the same period, of 1,072 snails crushed, 633 (59%) were infected. The true percentage of infections must have been even higher, since at least some of the snails crushed were from groups which had been isolated, and from which those snails actually giving off cercariae had been removed. In collections made in October-November 1951, and in May-September 1952, infections identified by crushing snails which had not been isolated previously were 1,159 of 1,758 (66%).

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[2] Several other types of cercarial infection were found in *Bembicium* spp., but *Parorchis* infections were readily distinguished by the large, characteristic rediae.

The high percentage of infection of the snail host seems somewhat surprising, in view of the fact that in 1939, only one of eight seagulls from this region was infected with *Parorchis acanthus*. However, silting up of the stream, which has occurred rapidly since 1937, has no doubt had a strong influence on the ecology of the region, and it may well be that in 1939 *Bembicium auratum* was not a common member of the fauna as it is today.

These cercariae have also been found in *B. nanum* (Lamarck) and *B. melanostoma* (Gmelin), but the percentage of infection is much less in both species than in *B. auratum*. It is, however, impossible to draw any conclusions as to any host preference shown by the parasite, because of the different habitats favoured by the three species of host. In the Patawalonga mud flats *B. auratum* is to be found at low tide in small pools where the chances of infection are high; at low tide *B. melanostoma* occupies more exposed positions on small rocks, mangroves, etc.; *B. nanum* lives on rocks which are exposed at low tide and subjected to strong wave action at high tide.

Parorchis cercariae were found by isolation in 1 of 360, and by crushing in 10 of 431 *Bembicium nanum* collected along the coast from Marino Rocks to Encounter Bay, South Australia, and in two of three *B. nanum* from the Patawalonga Creek (where infections were so common in *B. auratum*). The infection was not found by isolating over a hundred *B. nanum* collected in February 1952 along the coast of Yorke Peninsula; nor by crushing 50 of the snails collected south of Corny Point (Yorke Peninsula) and 15 from Salt Creek (Yorke Peninsula) in February 1953.

In October 1952, 11 of 434 *B. melanostoma* from Port River and Outer Harbour were found to be infected by crushing. In February 1953, of 450 *B. melanostoma* collected on Yorke Peninsula, five were infected. These five infected snails were from a collection of 50 taken at Port Wakefield, where conditions for infection must have been favourable; the remaining 400 were collected from Pine Point, Stansbury, Salt Creek, Edithburgh and Corny Point.

Infected snails will remain alive and continue to give off cercariae for some time under laboratory conditions. Eighteen *B. auratum* kept under observation survived 14, 30, 39, 49 (seven snails), 55 (three snails), 61, 88, 91 and 95 days respectively. Anderson (1953) kept 20 snails out of water for three months; of the six which survived, five contained rediae.

Other gastropods which were examined during this investigation were: 98 *Melaraphe unifasciata* and 42 *Austrocochlea concamerata* from Hallett's Cove; 22 *A. torri* from Marino Rocks, and a number of *Salinator fragilis* and *S. solida* from the Patawalonga. None of these gave off cercariae when isolated. Snails from Yorke Peninsula were examined after crushing: 50 *Neothais textiliosa* (Thaididae) from an ocean beach south of Corny Point were uninfected, but two of 13 *Emozamia flindersi* (Muricidae) from Port Vincent, and two of 71 of the same host from Pine Point were infected with *Parorchis acanthus* var. *australis*.

DISTRIBUTION AND HOSTS OF *PARORCHIS ACANTHUS*

Adult

P. acanthus has been recorded from the herring gull (*Larus argentatus*) from Great Britain and from the east coast of North America; the common gull (*L. canus*) from Scotland; the western gull (*L. occidentalis*) from the west coast of North America; the flamingo (*Phoenicopterus ruber*) from Cuba (Vigueras, 1941); and, as a result of experimental feeding, from terns (*Sterna hirundo* and *S. dougalli*) from Massachusetts.

Parorchis acanthus var. *australis* is now recorded from South Australia. The adult was found by the late Professor Harvey Johnston in only one of 25

seagulls (*Larus novae-hollandiae*) examined between 1937 and 1951. This positive host was one of eight gulls caught at Glenelg in 1939; it contained two adults and one immature specimen of the fluke. The remaining negative birds were from other parts of St. Vincent's Gulf (5), American River, Kangaroo Island (1), and River Murray (11).

CERCARIA

The cercaria has been recorded from *Nucella lapillus* and *Urosalpinx cinereus* from Great Britain and Massachusetts, U.S.A., and from *Thais emarginata* from Oregon. *Cerithidea californica* from California also harbours rediae and cercariae which are very probably the larval stages of *Parorchis acanthus*.

The known South Australian molluscan hosts of *P. acanthus* var. *australis* are *Bembicium auratum*, *B. melanostoma*, *B. nanum* and *Emozamia flindersi*.

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